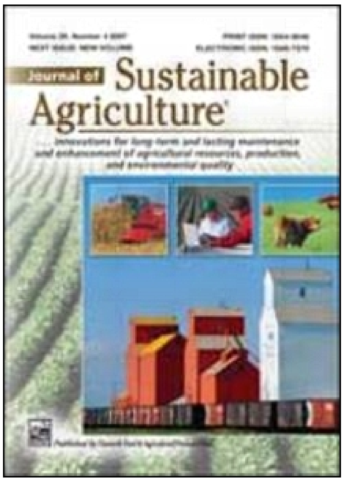

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Effects of Hairy Vetch (*Vicia villosa*) Cover Crop and Banded Herbicides on Weeds, Grain Yield, and Economic Returns in Corn (*Zea mays*)

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Effects of Hairy Vetch (*Vicia villosa*) Cover Crop and Banded Herbicides on Weeds, Grain Yield, and Economic Returns in Corn (*Zea mays*)

C. H. Koger
K. N. Reddy

ABSTRACT. A two-year field study was conducted during 2002-2003 on a Dundee silt loam soil, Stoneville, MS, to examine the effects of hairy vetch cover crop (HV-D, hairy vetch desiccated at corn planting; HV-B, hairy vetch desiccated in a 38-cm band over crop row at corn planting; and no hairy vetch) and preemergence (PRE) plus postemergence (POST) herbicides applied broadcast and banded on weed control, yield, and economic return in corn. Atrazine plus metolachlor were applied PRE and POST. Bentazon in 2002 and carfentrazone in 2003 were applied in mixture with atrazine plus metolachlor POST. More hairy vetch dry biomass was present in the HV-B system (2,941 kg/ha) than in the HV-D (1,397 kg/ha) and no hairy vetch (0 kg/ha) systems at 7 wk after planting corn (WAP). Live and desiccated hairy vetch in HV-B and HV-D systems suppressed pitted morning glory compared with no hairy vetch at 7 WAP. Densities of barnyardgrass, carpetweed, smooth pigweed, or yellow nutsedge were not reduced in HV-D and HV-B systems compared with no hairy vetch. Hairy vetch cover crop residue in HV-D and HV-B systems had no effect on total weed dry biomass at 7 WAP compared with no hairy vetch. Corn yields were higher in the HV-D system, regardless of herbicide treatment, and the HV-B with broadcast-applied

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PRE plus POST herbicide treatment compared with no hairy vetch treatments in 2003. Corn yields were similar with band- and broadcast-applied PRE plus POST herbicides when no hairy vetch or all hairy vetch was desiccated at planting (HV-D). Higher costs associated with hairy vetch were offset by higher corn yields in the HV-D system compared with no hairy vetch in 2003, as net returns were similar in both systems. Applying PRE plus POST herbicides in a band resulted in similar net returns as broadcast herbicide application in the no hairy vetch and HV-D systems. These findings indicate that hairy vetch cover crop had little effect on reducing densities of weed species studied, higher costs associated with cover crops can be negated with higher corn yields, and herbicide inputs can be reduced by applying herbicides in a band vs. broadcast without reducing corn yields or economic returns.

KEYWORDS. Cover crop, economic analysis, integrated weed management, net returns, weed control, weed density, weed biomass

INTRODUCTION

Atrazine and metolachlor are commonly used to control grass and broadleaf weeds in corn (*Zea mays* L.) (Culpepper and York, 1999; Curran et al., 1994; Fausey and Renner, 2001; Ferrell and Witt, 2002; Grier and Stahlman, 1999; Tharp and Kells, 2002; Webster et al., 1998). Atrazine and metolachlor were used to treat over 21 and 1.7 million ha of corn, respectively, in the United States in 2001 (Anonymous, 2001). Atrazine and metolachlor are also among the pesticides most frequently found in ground and surface waters via transport mechanisms such as surface runoff and leaching (Goolsby et al., 1997; NRC, 1989). Thus weed management systems are needed that minimize the potential environmental impact of these herbicides.

Hairy vetch (*Vicia villosa* Roth) is a winter annual legume used as a cover crop in many of the corn producing areas of the United States. Hairy vetch produces large amounts of biomass and often more nitrogen than other legumes (Decker et al., 1994; Ebelhar et al., 1984; Sainju and Singh, 1997; Wagger, 1989). Cover crops and their residues have been used to suppress early-season weed pressure in many crops (Burgos and Talbert, 1996; Ilnicki and Enache, 1992; Koger et al., 2002; Reddy, 2003; Reddy et al., 2003; Teasdale and Daughtry, 1993). Hairy vetch residues also exude allelochemicals that inhibit germination of select weed species (Bradow et al., 1990; White et al., 1989). Cover crops are also utilized to reduce soil erosion and water runoff, improve soil physical and chemical properties, sequester atmospheric CO_2 into soil, and conserve leachable plant nutrients (Clark et al., 1995; Decker et al., 1994; Locke and Bryson, 1997; Mallory et al., 1998; Sainju and Singh, 1997; Yenish et al., 1996). Cover crops such as hairy vetch have also long been used to biologically fix atmospheric-nitrogen, which subsequently becomes available to a crop during residue decomposition (Ebelhar et al., 1984; Sainju and Singh, 1997; Teasdale and Shirley, 1998; Wagger, 1989).

Cover crops are planted in the fall and desiccated with herbicides the following spring before no-till planting of the summer crop (Koger et al., 2002; Reddy et al., 2003). In Mississippi, most spring growth of hairy vetch occurs between March and May. Corn is usually planted during 25 February to 10 April in southern Mississippi and during 15 March to 25 April in northern Mississippi (Anonymous, 2003a). Thus the period of maximum cover crop growth and normal corn planting dates overlap. Generally, cover crops are killed at or before corn planting. If left alive, hairy vetch will continue to grow until natural senescence occurs or killed by POST herbicides. Live hairy vetch at corn planting can adversely affect corn stand establishment mainly due to poor seedling emergence in excessive hairy vetch biomass. One way to overcome the poor stand establishment is to kill the hairy vetch in a band over the crop row. The desiccated band can provide a favorable environment for corn seedlings to emerge and live hairy vetch between the rows will continue to suppress weeds.

Although hairy vetch aids in early-season weed suppression, herbicides generally are required to achieve full-season weed control and optimum corn yields (Curran et al., 1994; Johnson et al., 1993; Teasdale and Shirley, 1998). Weed suppression effects of cover crop residue decrease with time following cover crop residue decomposition. Warm winter and spring temperatures, relatively high rainfall, and fertile soils of the lower Mississippi River Delta region provide a conducive environment for establishment of a wide array of annual and perennial weed species throughout the growing season (Heatherly and Elmore, 1983; Reddy 2001). Having live hairy vetch between corn-rows and desiccated vetch in-row could provide short-term weed control, sequestration of atmospheric-nitrogen, and may reduce the requirements for PRE and POST herbicides. Live hairy vetch cover crop provided effective weed suppression longer than desiccated hairy vetch residue (Teasdale and Daughtry, 1993). Light exclusion and reduction in diurnal soil temperature requirements under live hairy vetch can reduce weed seed germination and emergence compared with desiccated vetch or bare soil (Teasdale and Daughtry, 1993).

Numerous studies have shown that regardless of summer crop, additional weed management tactics are necessary, as cover crops often do not provide season-long weed control. Information is lacking on integration of live hairy vetch and PRE plus POST herbicides in corn in the lower Mississippi River Delta region. The objectives of this research were (1) to determine the impact of band- and broadcast-desiccation of hairy vetch cover crop on weeds and corn yield, (2) to determine the efficacy of PRE plus POST herbicides applied as broadcast vs. in a band over the crop row on weeds and corn yield, and (3) the economic costs and returns of hairy vetch and PRE plus POST herbicide systems.

MATERIALS AND METHODS

Field studies were conducted during 2002 and 2003 at the USDA-ARS Southern Weed Science Research farm, Stoneville, Mississippi (33°26′ N latitude). The soil was a Dundee silt loam (fine-silty, mixed, thermic Aeric Ochraqualf) with 26% sand, 56% silt, and 18% clay. The experimental area was in soybean production prior to initiation of the study. The experiment was conducted in a split-split plot arrangement of treatments in a randomized complete block design with cover crop system as the main plot and herbicide system as the subplot with four replications. Each subplot consisted of four 15.2 m long rows of corn spaced 102 cm apart. The same treatment was assigned to the same plot both years to evaluate accumulative effects of the integration of cover crop and herbicide systems. Field preparation consisted of disking and bedding in the fall of 2001. In 2002, after corn harvest, the beds were reformed without disking. Hairy vetch was drilled in 19-cm-wide rows using a no-till grain drill (Deere and Co., Moline, IL 61265) in mid-October of 2001 and 2002 at a seeding rate of 30 kg/ha.

Cover crop systems were hairy vetch desiccated at corn planting (HV-D), hairy vetch desiccated in a 38-cm band over the crop row at corn planting (HV-B), and no hairy vetch. The hairy vetch cover crop was killed as per treatment with paraquat at 1.1 kg ai/ha a day before planting corn. At desiccation, hairy vetch was 25 cm to 30 cm tall. No hairy vetch plots were also treated with paraquat at 1.1 kg ai/ha to kill existing vegetation. Corn was planted without tillage directly into desiccated or no hairy vetch residue. The corn cultivar 'Pioneer 3223' was planted on April 5, 2002 and April 1, 2003. Corn was planted in 102 cm rows using a MaxEmerge 2 planter (Deere and Co., Moline, IL 61265) at 80,000 seeds/ha. The insecticide terbufos at 4.58 kg/ha was applied in-furrow at planting. At planting, 135 kg/ha nitrogen (32% N liquid solution) was applied in corn furrow. An additional 67 kg/ha nitrogen was side-dressed at 4 wk after planting (WAP). Rainfall during April through July was 34.3 cm and 40.9 cm in 2002, and 2003, respectively. The 30-year average rainfall for the corresponding period is 45 cm. Corn was flood irrigated on June 3 and 24 in 2002 and June 2 and 27 in 2003.

Herbicide treatments consisted of preemergence (PRE) plus postemergence (POST) herbicides applied as broadcast, in a 38-cm band over crop row, and a no-herbicide treatment. Atrazine at 1.82 kg/ha plus metolachlor at 1.41 kg/ha were applied PRE in a band and as broadcast. In 2002, PRE herbicides were followed by (fb) 0.95 kg/ha atrazine plus 0.74 kg/ha metolachlor plus 0.84 kg/ha bentazon POST applied in a band or as broadcast at 4 WAP. Atrazine (0.85 kg/ha) plus metolachlor (0.74 kg/ha) plus carfentrazone (8.8 g/ha) were applied POST in a band or as broadcast at 4 WAP in 2003. A nonionic surfactant (Induce® Helena Chemical Co., Memphis, TN 38119) at 0.25% (v/v) was added to all POST treatments as suggested by the manufacturer. Herbicide treatments were applied with standard flat spray tips (Spraying Systems Co., Wheaton, IL 60189) using a tractor-mounted sprayer delivering 187 L/ha water at 179 kPa to 186 kPa. Herbicides were applied using a hooded sprayer equipped with two off-center nozzles (OC-01 flat spray tips) for post-direct spraying to each corn-row and sprayer hoods with three nozzles (95002 even flat spray tips) for spraying between the rows. Broadcast herbicides were applied with post-directed and sprayer hood spray tips. Banded herbicides were applied with post-directed tips, while tips under sprayer hoods were plugged. Spray pressure for banded treatments was adjusted to obtain desired spray volume. As expected, band application used 63% less herbicides compared with broadcast application.

Hairy vetch cover crop biomass was determined at corn planting, and 3 and 7 WAP. Hairy vetch plant residue was clipped at soil surface from one randomly selected 0.09 m^2 quadrat, oven-dried, and weighed. Weeds were counted by species in one 1.0 m^2 area in each plot at 7 WAP. Dry weight of all weeds present was recorded from one randomly selected 1.0 m^2 area within each plot at 7 WAP. Hairy vetch biomass, weed counts, and weed biomass data were recorded between the second and third row of each plot. Corn population was determined by counting plants in two 1.0 m lengths in each plot at 6 WAP. Corn plant height from soil surface to tip of the youngest leaf was measured on five randomly selected plants at 6 WAP. Corn population and corn plant height data were recorded in the second and third row of each plot. Corn was harvested from the second and third rows of each plot on August 22, 2002 and August 18, 2003 using a combine and grain yield was adjusted to 15% moisture.

Total estimated costs of production were determined for each treatment in each year and included all direct and fixed costs, but excluded costs for land and management using enterprise budgets compiled by the Mississippi Agricultural and Forestry Experiment Station (Anonymous, 2002, 2003b). Treatment costs included only those directly associated with each treatment such as seed, planting, desiccation of hairy vetch, herbicides, adjuvants, and applications. Prices for hairy vetch seed were obtained from major suppliers in the region. Treatment and other costs for each year are listed in Table 1. Gross income was calculated for each treatment using an average corn price of \$0.078/kg in 2002 and \$0.083/kg in 2003. Net return was determined by subtracting the estimated total cost of production from gross income for each treatment (Reddy, 2001).

The data were subjected to analysis of variance using Proc Mixed to determine significance of main effects and interactions (SAS, 1998). Main effects and interactions were tested by the appropriate mean square associated with the random variables (McIntosh, 1983). Data were averaged across years (as main effect means) when interactions were not significant and are presented for interactions where appropriate. Treatment means were separated at the 5% level of significance using Fisher's Protected LSD test.

RESULTS AND DISCUSSION

Hairy Vetch Dry Biomass

Hairy vetch produced a uniform stand and complete ground cover in both years, with an average of 2,340 kg/ha of hairy vetch dry biomass by time of corn planting (data not shown). Planting and fertilization operations killed approximately 40% of vetch and reduced vigor of plants in tire tracks in all treatments. Complete desiccation (HV-D) of hairy

TABLE 1. Estimated costs of various inputs for hairy vetch and PRE plus POST herbicide systems used in corn production in 2002 and 2003, Stoneville, MS.[a]

Input	Estimated cost[b]	
	2002	2003
Treatment costs	—— $/ha ——	
No hairy vetch		
Desiccation[c]	30.38	31.49
Herbicide application	9.14	9.16
Hairy vetch		
Seed + inoculant + planting	78.96	79.76
Desiccation broadcast[c]	30.38	31.49
Desiccation banded[c]	11.31	11.73
Herbicide application	9.14	9.16
Herbicide		
No herbicide	0	0
PRE + POST broadcast[d]	106.85	84.72
PRE + POST banded[d]	39.79	31.55
Application of PRE and POST herbicides	16.62	16.79
Other costs		
Fall tillage	25.34	11.83
Corn seed + insecticide + planting	135.99	146.96
Fertilizer + application	74.03	123.33
Irrigation[e]	51.57	53.35
Harvest + hauling	123.89	138.71

[a] Cost of desiccation and POST herbicides include cost of adjuvant.

[b] Costs derived from enterprise budgets compiled by Mississippi Agriculture and Forestry Experiment Station.

[c] Paraquat at 1.12 kg/ha applied as desiccant.

[d] Atrazine plus metolachlor at 1.82 plus 1.4 kg/ha were applied PRE in both years. Atrazine (0.95 kg/ha) plus metolachlor (0.75 kg/ha) plus bentazon (0.82 kg/ha) in 2002 or carfentrazone (8.8 g/ha) in 2003 were applied POST once in a 38-cm band and as broadcast.

[e] Cost of pumping, roll-out pipe, and pipe installation and removal.

vetch resulted in less plant residue at 3 WAP compared with desiccation of a 38-cm band (HV-B) over the corn-row (Table 2). More residue was present at 3 WAP in both hairy vetch treatments (HV-D and HV-B) when compared with no hairy vetch plots. Plant biomass in the no hairy

TABLE 2. Hairy vetch residue at 3 and 7 WAP as affected by cover crop systems and PRE + POST herbicide programs in 2002 and 2003.[a]

Main effect	Hairy vetch dry biomass[b] 3 WAP	7 WAP
	kg/ha	
Cover crop		
No hairy vetch	768	0
HV-D	1,926	1,397
HV-B	2,672	2,941
LSD (0.05)	446	640
PRE + POST herbicides[c]		
No herbicide	1,903	1,414
Band applied	1,744	1,489
Broadcast applied	1,719	1,436
LSD (0.05)	NS	NS

[a] Abbreviations: HV-D, hairy vetch desiccated at corn planting; HV-B, hairy vetch desiccated in a 38-cm band over the crop row at corn planting; PRE, preemergence; POST, postemergence; WAP, wk after planting corn; NS, not significant.

[b] Data represent an average of 2 yr as treatment by year interaction was not significant at P = 0.05 level of significance. Biomass in no hairy vetch was from winter annuals.

[c] Atrazine plus metolachlor at 1.82 plus 1.4 kg/ha were applied PRE in both years. Atrazine (0.95 kg/ha) plus metolachlor (0.75 kg/ha) plus bentazon (0.82 kg/ha) in 2002 or carfentrazone (8.8 g/ha) in 2003 were applied POST in a 38-cm band and as broadcast.

vetch plots was from an infestation of winter annuals. Predominant weed species included annual bluegrass (*Poa annua* L.), Carolina foxtail (*Alopecurus carolinianus* Walt.), hairy buttercup (*Ranunculus sardous* Crantz), henbit (*Lamium amplexicaule* L.), shepherdspurse [*Capsella bursa-pastoris* (L.) Medik.], sibara [*Sibara virginica* (L.) Rollins], and swinecress [*Coronopus didymus* (L.) Sm.].

Similar to residue biomass at 3 WAP, more residue was present in the HV-B treatment (2,941 kg/ha) when compared with HV-D (1,397 kg/ha) and no hairy vetch (0 kg/ha) by 7 WAP (Table 2). Live hairy vetch between rows of corn in HV-B plots continued to grow until senescence, from 2,672 kg/ha residue at 3 WAP to 2,941 kg/ha at 7 WAP.

There were no differences in biomass of cover crop residue among herbicide treatments regardless of application method at 3 and 7 WAP when averaged across all three cover crop systems. Little to no reduction in cover crop biomass at 3 and 7 WAP may be also be due to advanced stage of development for hairy vetch by the time of application of POST herbicides and/or slow decomposition of freshly desiccated residue during a narrow window of time between POST treatments and sampling date.

Weed Density and Biomass

Thirteen weed species were present in the no herbicide control plots at 7 WAP. Barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.], carpetweed (*Mollugo verticillata* L.), pitted morning glory (*Ipomoea lacunosa* L.), smooth pigweed (*Amaranthus hybridus* L.), and yellow nutsedge (*Cyperus esculentus* L.) accounted for the majority (7% to 40%) of the total weed density. Densities of other weed species were less than 0.5% of the total weed density, and were not reported. Live and desiccated hairy vetch in HV-B and HV-D treatments suppressed pitted morning glory compared with the no hairy vetch at 7 WAP (Table 3). Density of pitted morningglory was also lower in the HV-B treatment compared with HV-D treatment. However, a pitted morning glory density of 0.2 plants/m^2 was still present in HV-B plots at 7 WAP. Densities of barnyardgrass, carpetweed, smooth pigweed, or yellow nutsedge were not reduced in HV-D and HV-B treatments compared with no hairy vetch.

Broadcast-applied PRE plus POST herbicides provided 100% control of all weed species except yellow nutsedge, which was present at a density of 1.1 plants/m^2 at 7 WAP (Table 3). Herbicides (PRE plus POST) applied in a band over the corn-row reduced densities of carpetweed, smooth pigweed, and yellow nutsedge to similar levels as broadcast-applied PRE plus POST herbicides. However, densities of barnyardgrass, pitted morning glory, smooth pigweed, yellow nutsedge at 7 WAP ranged from 1.3 to 8.6 plants/m^2 in plots where PRE plus POST herbicides were applied in a band.

Hairy vetch cover crop had no effect on total weed dry biomass at 7 WAP, regardless of type of desiccation, when compared with no hairy vetch (Table 3). Herbicides applied PRE plus POST in a band or broadcast reduced total weed dry biomass compared with no herbicide. Method of herbicide application (band and broadcast) did not affect total weed dry biomass. Total weed dry biomass was 59 and 3 kg/ha at 7

TABLE 3. Weed density at 7 WAP as affected by hairy vetch cover crop and PRE + POST herbicide systems in 2002 and 2003.[a,b]

Main effect	Barnyard-grass	Carpetweed	Pitted morning glory	Smooth pigweed	Yellow nutsedge	Total weed dry biomass[d]
	plants/m²					kg/ha
Cover crop						
No hairy vetch	10.3	2.1	2.8	9.3	17.8	102
HV-D	7.6	1.4	1.4	2.1	6.5	93
HV-B	6.3	1.9	0.2	3.4	12.2	95
LSD (0.05)	NS	NS	1.1	NS	NS	NS
PRE + POST herbicides[c]						
No herbicide	17.2	3.1	3.2	13.2	28.2	228
Band applied	7.5	0	1.3	1.5	8.6	59
Broadcast applied	0	0	0	0	1.1	3
LSD (0.05)	6	1.2	1.2	3	13	120

[a] Abbreviations: HV-K, hairy vetch desiccated at corn planting; HV-B, hairy vetch desiccated in a 38-cm band over the crop row at corn planting; PRE, preemergence; POST, postemergence; WAP, wk after planting corn; NS, not significant.

[b] Data represent an average of 2 yr, as treatment by year interaction was not significant at P = 0.05 level of significance.

[c] Atrazine plus metolachlor at 1.82 plus 1.4 kg/ha were applied PRE in both years. Atrazine (0.95 kg/ha) plus metolachlor (0.75 kg/ha) plus bentazon (0.82 kg/ha) in 2002 and carfentrazone (8.8 g/ha) in 2003 were applied POST once in a 38-cm band and as broadcast.

[d] Summed biomass of barnyardgrass, carpetweed, pitted morning glory, smooth pigweed, and yellow nutsedge.

WAP in plots treated with band and broadcast herbicides, respectively, compared with 228 kg/ha in no herbicide plots. Overall low weed dry biomass in this study may have been due to unfavorable conditions for early-season weed seed germination and poor establishment of seedlings under corn canopy. Additionally, corn planted in early March to April in the southeastern US can reach full canopy closure before optimal germination conditions for some weed species occur.

Corn Population, Height, and Yield

Corn population was similar among hairy vetch and herbicide systems, regardless of hairy vetch desiccation type or herbicide application method (Table 4). Others have reported reduced corn population after planting into live hairy vetch (Teasdale and Shirley, 1998; Johnson et al., 1993; Curran et al., 1993). Despite hairy vetch dense groundcover, the corn planter was able to place corn seed in sufficient contact with soil. Furthermore, rainfall of at least 4.8 cm occurred within 6 d of corn planting in both years. These conditions may have favored uniform corn stand establishment in the current study. Corn plant height was similar between HV-D and no hairy vetch systems, but higher when compared with HV-B system (Table 3). Soil moisture depletion by live hairy vetch may have increased stress on corn during early season in the HV-B sys-

TABLE 4. Corn population and plant height at 6 WAP as affected by hairy vetch cover crop and PRE + POST herbicide systems in 2002 and 2003.[a,b]

Main effect	Corn population	Corn plant height
	plants/ha	cm
Cover crop		
No hairy vetch	73,340	65
HV-D	76,465	66
HV-B	77,465	60
LSD (0.05)	NS	3
PRE + POST herbicides[c]		
No herbicide	75,006	63
Band applied	75,840	64
Broadcast applied	76,882	65
LSD (0.05)	NS	NS

[a] Abbreviations: HV-D, hairy vetch desiccated at corn planting; HV-B, hairy vetch desiccated in a 38-cm band over the crop row at corn planting; PRE, preemergence; POST, postemergence; WAP, wk after planting corn; NS, not significant.

[b] Data represent an average of 2 yr, as treatment by year interaction was not significant at P = 0.05 level of significance.

[c] Atrazine plus metolachlor at 1.82 plus 1.4 kg/ha were applied PRE in both years. Atrazine (0.95 kg/ha) plus metolachlor (0.75 kg/ha) plus bentazon (0.82 kg/ha) in 2002 and carfentrazone (8.8 g/ha) in 2003 were applied POST once in a 38-cm band and as broadcast.

tem. Total rainfall for the month of April was 39% and 29% less in 2002 and 2003, respectively, than the normal monthly rainfall. There were no differences in corn plant height among herbicide treatments.

There was no difference in corn yield among all cover crop by herbicide treatments in 2002 (Table 5). Corn yields in 2002 ranged from 9,117 kg/ha for the HV-B plus no herbicide treatment to 10,831 kg/ha for the no hairy vetch plus PRE plus POST herbicides applied in a band over the corn-row. Lack of differences in corn yield in 2002 may be due to less weed pressure in 2002 compared with 2003. Overall, densities and biomass of weeds were lower in 2002 when compared to 2003 (data not shown).

Corn yields in 2003 ranged from 6,520 kg/ha in the HV-B plus no herbicide treatment to 11,385 kg/ha in the HV-D plus PRE plus POST herbicide treatment. Corn yield was highest in the HV-D system, compared with the HV-B and no hairy vetch system (Table 5). Corn yields were lower with no hairy vetch cover crop, regardless of herbicide system, when compared to HV-D treatments. Enhanced corn yield in HV-D plots may be due to supplemental nitrogen provided by decaying hairy vetch cover crop residue. Competition from live hairy vetch in the HV-B plus no herbicide and HV-B plus banded PRE plus POST herbicides reduced corn yield compared to all HV-D treatments, regardless of herbicide system, and HV-B plus broadcast PRE plus POST herbicides. Differences in corn yields were partly due to the effect of live hairy vetch on corn growth. Although hairy vetch had no effect on corn stand establishment, it reduced corn plant height in the HV-B system. This reduced growth and yield could be attributed to greater competition by hairy vetch.

A hairy vetch cover crop may also prove useful for reducing environmental impact of herbicides and reduce herbicide inputs without sacrificing crop yield. A hairy vetch cover crop reduced the need for herbicides and resulted in higher corn yield in some cases. When no herbicides were used, corn yield was higher in the HV-D system compared with no hairy vetch and HV-B systems (Table 5). Corn yield in HV-B plots was higher when PRE plus POST herbicides were applied broadcast compared with no herbicide and band-applied PRE plus POST herbicides. Higher yield in the broadcast PRE plus POST herbicide plots may be partially due to the substantial activity of carfentrazone POST on hairy vetch, thus resulting in less competition from live hairy vetch cover crop.

TABLE 5. Effect of hairy vetch cover crop and PRE and POST herbicides on total weed dry biomass at 7 WAP and corn yield in studies conducted at Stoneville, MS, in 2002 and 2003.[a]

		Corn yield	
Cover crop	Herbicide[b]	2002	2003
		kg/ha	
No hairy vetch	No herbicide	10,326	8,956
	PRE + POST banded	10,831	9,441
	PRE + POST broadcast	10,295	9,485
	Mean	10,484	9,294
HV-D	No herbicide	10,046	10,395
	PRE + POST banded	10,401	10,706
	PRE + POST broadcast	10,295	11,385
	Mean	10,247	10,829
HV-B	No herbicide	9,117	6,520
	PRE + POST banded	9,974	8,657
	PRE + POST broadcast	10,594	10,532
	Mean	9,895	8,596
Mean	No herbicide	9,830	8,623
	PRE + POST banded	10,402	9,601
	PRE + POST broadcast	10,395	10,467
LSD (0.05)	Cover crop	NS	850
	Herbicide	NS	896
	Interaction	NS	960

[a] Abbreviations: HV-D, hairy vetch desiccated at corn planting; HV-B, hairy vetch desiccated in a 38-cm band over the crop row at corn planting; PRE, preemergence; POST, postemergence; WAP, wk after planting corn; NS, not significant.

[b] Atrazine plus metolachlor at 1.82 plus 1.4 kg/ha were applied PRE in both years. Atrazine (0.95 kg/ha) plus metolachlor (0.75 kg/ha) plus bentazon (0.82 kg/ha) in 2002 and carfentrazone (8.8 g/ha) in 2003 were applied POST once in a 38-cm band and as broadcast.

Economic Return

Treatment costs in 2002 and 2003 were highest for HV-D plus PRE plus POST herbicide treatment ($242 and $222/ha), respectively, and lowest for the no hairy vetch plus no herbicide treatment ($39 and $40/ha), respectively (Table 6). Cost of band-desiccation of hairy vetch was $19 and $20/ha lower in 2002 and 2003, respectively, compared with broadcast desiccation. Banding PRE plus POST herbicides saved $67 and $54/ha compared with broadcast application of PRE plus POST herbicides. The difference in herbicide costs between years was attributed to

TABLE 6. Treatment cost and net return as affected by hairy vetch cover crop and PRE plus POST herbicide systems in studies conducted at Stoneville, MS, in 2002 and 2003.[a]

Cover crop	Herbicide[b]	Treatment cost[c]		Net return[d]	
		2002	2003	2002	2003
		$/ha			
No hairy vetch	No herbicide	39	40	352	162
	PRE + POST banded	96	89	331	152
	PRE + POST broadcast	162	142	222	102
	Mean	99	90	301	139
HV-D	No herbicide	118	120	247	195
	PRE + POST banded	175	169	218	171
	PRE + POST broadcast	242	222	143	171
	Mean	178	170	203	179
HV-B	No herbicide	99	101	193	−87
	PRE + POST banded	156	149	204	30
	PRE + POST broadcast	223	202	186	124
	Mean	159	150	194	22
Mean	No herbicide	86	87	264	90
	PRE + POST banded	142	135	251	118
	PRE + POST broadcast	209	189	184	132
LSD (0.05)	Cover crop			54	73
	Herbicide			62	NS
	Interaction			NS	110

[a] Abbreviations: HV-D, hairy vetch desiccated at corn planting; HV-B, hairy vetch desiccated in a 38-cm band over the crop row at corn planting; PRE, preemergence; POST, postemergence; NS, not significant.

[b] Atrazine plus metolachlor at 1.82 plus 1.4 kg/ha were applied PRE in both years. Atrazine (0.95 kg/ha) plus metolachlor (0.75 kg/ha) plus bentazon (0.82 kg/ha) in 2002 and carfentrazone (8.8 g/ha) in 2003 were applied POST once in a 38-cm band and as broadcast.

[c] Treatment costs include only those associated with treatments such as seed, planting, desiccation of cover crops, herbicide, adjuvant, and application costs.

[d] Net return was calculated by subtracting total production costs from gross income. Total production costs include both treatment costs and other (corn seed, planting, irrigation, harvesting, and hauling) costs that are common to all treatments.

the lower cost of carfentrazone in 2003 compared with price of bentazon in 2002.

Net returns were higher in 2002 compared to 2003 due to substantially higher fertilizer cost and lower corn yields for most treatments in 2003 (Table 6). Costs associated with hairy vetch cover crop (seed, inoculant, planting, desiccation) resulted in lower net returns in 2002 for the HV-D and HV-B systems compared with the no hairy vetch system. Averaged across herbicide system, net returns were \$98 and \$107/ha lower with HV-D and HV-B systems compared with no hairy vetch. The highest net return in 2002 was with the no hairy vetch plus no herbicide system and lowest was the HV-D plus broadcast-applied PRE plus POST herbicide system.

In 2003, net returns were higher for no hairy vetch and HV-D systems, regardless of herbicide system, when compared to the HV-B system (Table 6). This was attributed to lower corn yields in the HV-B system. Costs associated with hairy vetch were offset by higher corn yields in the HV-D system compared with no hairy vetch. Thus, net returns were similar in both systems, regardless of herbicide system. Applying PRE plus POST herbicides in a band resulted in similar net returns as broadcast herbicide application.

In this study, hairy vetch cover crop, regardless of desiccation method, suppressed only one of five weed species evaluated, and did not reduce total weed dry biomass compared with no hairy vetch. Desiccation of hairy vetch cover crop over the corn-row compared to broadcast desiccation did not enhance weed control, reduced corn yield, and resulted in similar to lower net returns. The accumulative effect of placing treatments in the same plots in both years may have resulted in more supplemental nitrogen in the HV-D sys tem vs. no hairy vetch system, as corn yield in 2003 with broadcast desiccation of hairy vetch cover crop was higher when compared to no hairy vetch cover crop. However, costs associated with hairy vetch cover crop were not negated by higher corn yields, as net returns were similar to lower than returns for no hairy vetch system. Applying PRE plus POST herbicides in a band compared to broadcast application reduced herbicide inputs by 63% while providing similar levels of weed control, corn yield, and net returns when no hairy vetch was present or all hairy vetch was desiccated at planting.

This research indicates that a hairy vetch cover crop does not improve economic returns compared with no hairy vetch. However, a hairy vetch cover crop can be utilized in cases where environmental concerns for soil erosion and pesticide detection in ground and surface waters persist without sacrificing economic returns in some years, as net returns were similar between the no hairy vetch and complete desiccation of hairy vetch systems in one out of two years. Additionally, supplemental nitrogen produced by the integration of a hairy vetch cover crop into crop production systems may eventually reduce overall requirements for synthetic fertilizers. Enhanced moisture retention, organic matter content, and possible insect and disease reduction are factors difficult to associate dollar values with, but may be tangible benefits of a hairy vetch cover crop.

Regardless of the presence or absence of hairy vetch cover crop, herbicide use can be reduced by applying herbicides in a band compared to broadcast application without sacrificing weed control, corn yield, or net returns when there is no hairy vetch all hairy vetch is desiccated at time of planting. The integration of hairy vetch cover crop and herbicide systems was not beneficial, as economic returns were similar or higher for no hairy vetch compared with hairy vetch systems and weed control and economic returns were similar between band- and broadcast-applied herbicides regardless of absence or presence of hairy vetch cover crop. Additionally, reduction in use of desiccant type herbicides such as paraquat and the development of a more sustainable crop production system may be possible by mowing or rolling the cover crop prior to planting the summer annual crop. Overall herbicide inputs can be reduced by applying herbicides in a band while maintaining crop yields and providing a sustainable corn production system for growers.

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